CLAIMS

1. A method of controlling a sigma delta modulator with a loop which establishes a signal transfer function and a quantization noise transfer function of the sigma delta modulator, wherein the sigma delta modulator receives an input signal and provides a modulated output signal in response to the input signal; the method is characterized in comprising the step of:
controlling the sigma delta modulator to change the quantization noise transfer function in response to a signal feature which is correlated with the input signal.

2. A method according to claim 1, where the noise transfer function is changed to suppress quantization noise to a smaller extent when the signal feature represents a relatively large amplitude, whereas
when the signal feature represents a relatively small amplitude, the noise transfer function is changed to suppress quantization noise to a larger extent.

3. A method according to claim 1 or 2, where the noise transfer function is changed while the sigma delta modulator operates in a stable state.

4. A method according to any of claims 1 to 3, where the sigma delta loop comprises a loop filter which comprises a cascade of more than two integrators.

5. A method according to any of claims 1 to 4, where the sigma delta loop comprises a loop filter, and where shaping of the noise transfer function is controlled by changing filter coefficients of a loop filter to move zeroes or poles in the transfer function provided by the loop filter.

6. A method according to any of claims 1 to 5, where the loop filter comprises a cascade of integrator stages, and where shaping of the noise transfer

function is controlled by changing loss-coefficients of the integrators.

7. A method according to claim 6, where the loss-coefficients of the integrators are controllably adjustable between a lower value larger than the value zero and an upper value lower than or equal to one.

8. A method according to any of claims 1 to 7, where the sigma delta loop comprises a quantizer which quantizes an input to the quantizer in N_Q levels, where N_Q is larger than or equal to two levels, but less than six levels.

9. A method according to any of claims 1 to 8, where the sigma delta loop comprises a quantizer, and where shaping of the noise transfer function is controlled by changing thresholds of a quantizer of the loop.

10. A method according to any of claims 1 to 9, where the input signal is provided via a pre-filter which is controlled for selected values of the signal feature.

11. A method according to any of claims 1 to 10 comprising the step of: computing connected values of threshold peak values and selectable loop filter parameters, which are connected in the sense that for a given value of the signal feature, A(n), a nearest lower threshold peak value determines the threshold at which selectable loop filter parameters, when applied to the loop filter, provide a modulator which is stable for values of the signal feature.

12. A method according to any of claims 1 to 11, wherein the signal feature is the input signal of the modulator, and/or the output signal from the modulator and/or a state variable of the loop filter.

13. A method according to claim 12, wherein the signal feature is processed by a peak detector to provide an intermediate control signal based on which

a decision on which control signals to provide for control of the noise transfer function is performed.

14. A method according to claim 13, wherein the peak detector performs low-pass filtering of the signal feature and subsequently determines the numerical value of the low-pass filtered signal feature.

15. A method according to any of claims 13 to 14, wherein a running window of N previous samples of the output provided by the peak detector is stored, and wherein a maximum of the N previous samples is selected as the intermediate control signal.

16. A method according to any of claims 13 to 15, wherein the decision on which control signals to provide for control of the noise transfer function is performed by a lookup table which comprises stored control signals and associated with values or ranges of values of the intermediate control signal.

17. A method according to any of claims 1 to 16, wherein noise transfer functions which provide a maximum stable amplitude, MSA, located at least approximately 5% above an estimated peak value are selected.

18. A method according to any of claims 1 to 17, wherein a full-scale range of peak values of the signal feature is divided into a number of ranges, where each range is associated with a selectable noise transfer function.

19. A method according to any of claims 1 to 18 comprising the steps of:
for a given quantizer, determining:
minimum values (Amin) of a noise amplification factor for different loop filters;
a maximum stable amplitude value, MSA, which is selected such that input signal values less than MSA will provide a stable modulator;

creating a bank of different loop filters wherein each filter is related to a respective determined maximum amplitude value MSA;
selecting a filter from the bank in response to an adaptation signal which is correlated with the input signal.

20. A computer program which when run by a computer performs the method according to any of claims 1 to 19.

21. A computer readable medium encoded with a program which when run by a computer performs the method according to any of claims 1 to 19.

22. A sigma delta modulator with a loop which establishes a signal transfer function, STF, and a quantization noise transfer function, NTF, of the sigma delta modulator, where the sigma delta modulator receives an input signal, x(n), and provides a modulated output signal, y(n) in response to the input signal; characterized in that:
sigma delta modulator is configured to change the quantization noise transfer function, NTF, in response to a signal feature which is correlated with the input signal.

23. A sigma delta modulator according to claim 22, where the noise transfer function, NTF, is changed to suppress quantization noise to a smaller extent when the signal feature represents a relatively large amplitude, whereas
when the signal feature represents a relatively small amplitude, the noise transfer function is changed to suppress quantization noise to a larger extent.

24. A method according to any of claims 22 to 23, where the noise transfer function, NTF, is changed while the sigma delta modulator operates in a stable state.

25. A sigma delta modulator according to claim 22 or 24, where the sigma delta loop comprises a loop filter which comprises a cascade of more than two integrators.

26. A sigma delta modulator according to any of claims 22 to 25, where the sigma delta loop comprises a loop filter, and where shaping of the noise transfer function is controlled by changing filter coefficients of a loop filter to move zeroes or poles in the transfer function provided by the loop filter.

27. A sigma delta modulator according to any of claims 22 to 26, where the loop filter comprises a cascade of integrator stages, and where shaping of the noise transfer function is controlled by changing loss-coefficients of the integrators.

28. A sigma delta modulator according to claim 27, where the loss-coefficients of the integrators are controllably adjustable between a lower value larger than the value zero and an upper value lower than or equal to one.

29. A sigma delta modulator according to any of claims 22 to 28, where the sigma delta loop comprises a quantizer which quantizes an input to the quantizer in N_Q levels, where N_Q is larger than or equal to two levels, but less than six levels.

30. A sigma delta modulator according to any of claims 22 to 29, where the sigma delta loop comprises a quantizer, and where shaping of the noise transfer function is controlled by changing thresholds of a quantizer of the loop.

31. A sigma delta modulator according to any of claims 22 to 30, where the input signal is provided via a pre-filter which is controlled for selected values of the signal feature.

32. A sigma delta modulator according to any of claims 22 to 31 comprising the step of: computing coexisting values of amplitude ranges, MSA, and loop filter parameters, which are coexisting in the sense that for a given value of an amplitude range, the coexisting loop filter parameters, when applied to shape the loop filter, provide a modulator which is stable for signal amplitudes smaller than the given value of an amplitude range.

33. A sigma delta modulator according to any of claims 22 to 32, wherein the signal feature is the input signal of the modulator, and/or the output signal from the modulator and/or a state variable of the loop filter.

34. A sigma delta modulator according to claim 33, wherein signal feature is processed by a peak detector to provide an intermediate control signal based on which a decision on which control signals to provide for control of the noise transfer function is performed.

35. A sigma delta modulator according to claim 34, wherein the peak detector performs low-pass filtering of the signal feature and subsequently determines the numerical value of the low-pass filtered signal feature.

36. A sigma delta modulator according to any of claims 34 or 35, wherein a running window of N previous samples of the output provided by the peak detector is stored, and wherein a maximum of the N previous samples is selected as the intermediate control signal.

37. A sigma delta modulator according to any of claims 34 to 36, wherein the decision on which control signals to provide for control of the noise transfer

function is performed by a lookup table which comprises stored control signals and associated with values or ranges of values of the intermediate control signal.

38. A sigma delta modulator according to any of claims 22 to 37, wherein noise transfer functions which provide a maximum stable amplitude, MSA, located at least approximately 5% above an estimated peak value are selected.

39. A sigma delta modulator according to any of claims 22 to 38, wherein a full-scale range of peak values of the signal feature is divided into a number of ranges, where each range is associated with a selectable noise transfer function.

40. An analogue to digital converter comprising a sigma delta modulator according to any of the claims 22 to 39.

41. A digital to analogue converter comprising a sigma delta modulator according to any of the claims 22 to 39.

42. A microphone comprising a preamplifier and a sigma delta modulator according to any of the claims 22 to 39.

43. A class-D amplifier comprising a sigma delta modulator according to any of the claims 22 to 39.